KS 15538 L5A

FREQUENCY SELECTIVE VOLTMETER

2551 and Higher

INSTRUCTION MANUAL

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Section IV CALIBRATION AND MAINTENANCE

Page

A. CALIBRATION 4-1

1. Reference Oscillator 4-1

B. TROUBLESHOOTING 4-2

1. General Outline 4-2
2. Gains and Signal Levels 4-3
3. Procedures 4-3
4. Typical Transistor Trouble Shooting 4-14

C. ALIGNMENT AND ADJUSTMENTS 4-16

1. 1310 KC IF Amplifier Alignment. 4-16
2. Balanced Modulator Adjustment 4-16
3. 330 KC IF Amplifier Alignment 4-17/18
4. Variable Oscillator Alignment 4-17/18

Section V REPLACEABLE PARTS LIST

LIST OF ILLUSTRATIONS

Figure No. Page

1-1 KS15538, L5A Frequency Selective Voltmeter. 1-0
2-1 Controls and Indicators 2-2
3-1 Functional Block Diagram 3-2
4-1 Troubleshooting Test Setup 4-2
4-2 Module Location, Top View 4-4
4-3 Module Location, Rear View 4-5
4-4 Module Location, Rear View 4-6
4-5 Typical Transistor Trouble Shooting Schematic 4-14
4-6 KS15538, L5A Block Diagram 4-19/20
4-7 KS15538, L5A Schematic Diagram 4-21/22

LIST OF TABLES

Table No.		Page
4-1	Module Trouble Isolation	4-7
4-2	Battery Circuit Trouble Shooting	4-8
4-3	A1 Input Module Trouble Shooting	4-9
4-4	A2 Reference Oscillator Trouble Shooting	4-9
4-5	A4 Variable Oscillator Trouble Shooting	4-10
4-6	A3 Mixer-Modulator Module Trouble Shooting	4-10
4-7	A5 First IF Amplifier Module Trouble Shooting	4-11
4-8	A7 Second IF Amplifier Module Trouble Shooting	4-12
4-9	A8 Meter Amplifier Module Trouble Shooting	4-13
4-10	A6 Audio Amplifier and Detector Module Trouble Shooting	4-13
4-11	Transistor Voltage Measurements	4-15

Figure 1-1. KS15538, L5A Frequency Selective Voltmeter

SECTION I
GENERAL

A. PURPOSE

The Sierra KS15538, L5A Frequency Selective Voltmeter is designed to measure voltages from 245 microvolts to 9.75 volts in the frequency range 2 to 350 kc when connected to a 600 ohm line. It is designed to measure dbm from -80 to +22 when connected to 600 ohm or 135 ohm lines. The 500 cycle bandwidth makes it particularly useful for analyzing complex waveforms, determining carrier system levels, and checking amplitude modulation percentages.

B. DESCRIPTION

The KS15538, L5A, Figure 1-1, is a fully transistorized, battery-operated instrument. Special features include a 20 pin Western Electric input connector for patching into 135 ohm telephone carrier systems, an internal oscillator for calibration purposes and headphone jacks for audio monitoring. The instrument is housed in a compact metal cabinet.

The front panel contains all of the operating controls and is protected from damage by a metal cover that fastens in place by snaps. The function selector switch must be in the off position before the cover can be closed, thereby preventing the possibility of battery discharge while the instrument is not in use. The major portion of the circuitry is laid out on printed circuit boards and assembled into eight separate modules that are mounted on a main chassis by stand-off spacers. Extensive shielding is provided for modules and components to prevent interaction between circuits. The instrument is powered by six size D, 1.5 volt, zinc-carbon cells which provide up to 100 hours operation. Provision is made for changing batteries without removing the instrument from the case.

C. SPECIFICATIONS

Frequency Range	2 kc to 350 kc
Input Level	-80 dBm to +22 dBm
Frequency Accuracy	± 1kc

Measurement Accuracy	±1 dB (-70 dBm to +22 dBm)
Selective Voltmeter Bandpass	500 cps (±250 cps), 3 dB down 2200 cps, 60 dB down
Audio Monitor Bandpass	2.5 kc, 6 dB down 3.8 kc, 20 dB down
Meter Reading (Direct)	Dbm on 135 ohm and 600 ohm balanced or unbalanced lines. Voltage in 600 ohm input position only
Spurious Response	Greater than 50 dB down
Intermediate Frequencies	
1st IF	1310 kc
2nd IF	330 kc
Bridging Loss	Not greater than 0.25 dB in either 135 ohm or 600 ohm position
Power Requirements	6 size D cells
Current drain	20 ma nominal
Voltage	9 volts nominal
Battery Life	100 hours (nominal)
Temperature	+14 to +122°F
Overall Dimensions	
Width	12 inches
Height	7.5 inches
Depth	7.5 inches
Weight	15 pounds

D. INSTALLATION OF BATTERY CELLS

The voltmeter and six size D zinc-carbon cells, wrapped separately, are shipped in a corrugated fiberboard container.

CAUTION

The cells must be installed in accordance with the polarity markings on the battery pack. Improper installation will result in impared or non-operation of the instrument.

Access to the battery pack is through an opening in the left hand end of the instrument case. To install cells provided, or to replace worn out cells, proceed as follows:

1. Pull out the plungers in the two Nylatch fasteners and lift off plate.

2. Unscrew thumbscrew and lift off cover of battery pack. (Figure 4-4).

3. Place cells in tubes observing polarity markings. + means positive terminal up.

4. Replace battery pack cover. Be sure aligning pin fits into small hole made to receive it. The positive battery connector fits into a recessed epoxy-fiberglass disc to make contact.

5. Place outer cover plate fasteners in the two holes provided and push in plungers to lock in place.

SECTION II
OPERATION

A. OPERATING CONTROLS AND INDICATORS (Figure 2-1)

PANEL MARKING	DESCRIPTION	FUNCTION
FUNCTION	5 position rotary switch	(1) OFF position disconnects battery from voltmeter circuits. (2) BATT position checks condition of battery under full load. (3) CAL position connects internal reference oscillator output to the voltmeter circuits for instrument calibration. (4) 135 ohm position provides proper internal connections for 135 ohm lines connected to INPUT jacks or 20 pin connector. (5) 600 ohm position provides proper internal connections for 600 ohm lines connected to INPUT jacks only.
SELECTOR	9 position rotary switch	(1) INPUT position connects voltmeter input circuits to INPUT jacks. (2) IN and OUT positions connect voltmeter input circuits to 20 pin Western Electric connector.

2. Operational Calibration

This procedure calibrates the main tuning dial and the overall voltmeter sensitivity. To calibrate the voltmeter, proceed as follows:

a. Set FUNCTION selector switch to CAL position.

b. Set ATTENUATOR selector switch to 0 dB CAL position.

c. Rotate MAIN TUNING dial control to 25 kc.

d. Adjust FINE tuning control for maximum indication on dBm meter.

e. Adjust MAIN TUNING index control until index pointer is directly below the 25 kc mark on main tuning dial face.

f. Adjust CAL control for 0 dBm indication on dBm meter.

3. Particular Frequency Range Calibration

This procedure calibrates the test set for a particular frequency range.

a. Rotate the MAIN TUNING dial control to red mark nearest the frequency to be measured.

b. Rotate ATTENUATOR selector switch until dBm meter indication is in upper half of scale.

c. Adjust FINE tuning control for maximum indication on dBm meter.

d. Adjust MAIN TUNING index control until index pointer is directly below red mark on main tuning dial face. The voltmeter is now calibrated for the frequency range to be measured.

4. Line Measurements - 20 Pin Connector

The 20 pin Western Electric connector is provided for patching into 135 ohm carrier lines. To perform 135 ohm carrier line measurements, proceed as follows:

a. Patch voltmeter to circuit to be tested.

b. Calibrate voltmeter per paragraph 2.

c. Set FUNCTION selector switch to 135 ohm position.

d. Set SELECTOR switch to directional circuit to be measured.

e. Rotate MAIN TUNING dial control to frequency corresponding to directional circuit under test.

f. Rotate ATTENUATOR selector switch until dBm reading is in upper half scale.

g. Adjust FINE tuning control for maximum indication on dBm meter.

h. Read dBm meter indication. To obtain the input signal level, algebraically add the dBm meter indication to the attenuator setting.

5. Line Measurements - Input Jacks.

The INPUT jacks are provided for making measurements on 135 ohm or 600 ohm, balanced or unbalanced lines. To perform line measurements, proceed as follows:

a. Connect voltmeter to circuit to be tested. For unbalanced lines, use shorting link. For balanced lines, disconnect shorting link.

b. Calibrate voltmeter per paragraph 2.

c. Set FUNCTION selector switch to desired impedance setting (600 or 135 ohm).

d. Set SELECTOR switch to INPUT position.

e. Rotate MAIN TUNING dial control to frequency of signal to be measured.

f. Rotate ATTENUATOR selector switch until dBm meter indication is in upper half of scale.

g. Adjust FINE tuning control for maximum indication on dBm meter.

h. Read dBm meter indication. To obtain the input signal level, algebraically add the dBm meter indication to the attenuator setting.

6. Headphone Monitoring

Provision is made to monitor audio signals that may be present on line signals under measurement. To monitor audio signals, connect a headphone set, 600 ohm impedance or higher, to the jacks marked PHONES and adjust the AUDIO GAIN control for a suitable listening level. When using headphones with a single plug, insert plug into left-hand, J6. This jack controls power to audio output stages.

NOTE: With the Voltmeter calibrated and operating normally, internally generated noise will deflect the meter slightly upscale. This noise should not exceed the -20 dB mark on the meter and does not affect the measuring accuracy over the specified range.
Never adjust the mechanical zero set on the meter unless battery power is off.

SECTION III
THEORY OF OPERATION

A. FUNCTIONAL ANALYSIS

The KS15538, L5A employes a dual conversion superhetrodyne circuit to measure frequencies in the range of 2 kc to 350 kc with a bandpass of 500 cps. Figure 3-1 illustrates a functional block diagram of the frequency selective voltmeter.

At the input of the voltmeter, selector switches are used to select an input signal from either the 25 kc reference oscillator or from the front panel input connectors. A filter and matching network is incorporated in the input circuits to attenuate unwanted high frequency components and to provide proper input impedances. To control the sensitivity of the voltmeter, a variable attenuator provides up to 80 dB of attenuation in 5 dB steps.

Tuning of the voltmeter is accomplished by a variable oscillator that operates over the frequency range of 1310 kc to 1660 kc. Both the input signal and the variable oscillator signal are applied to a mixer stage where the first heterodyning action takes place to produce a 1310 kc difference frequency. The first IF amplifier is tuned to 1310 kc and amplifies the output of the first mixer.

A second mixer stage heterodynes a 1640 kc local oscillator signal with the first IF signal to produce a 330 kc difference frequency. The 500 cps bandpass of the voltmeter is determined by a crystal filter located between the second mixer and the second IF. After amplification by the second IF amplifier, the signal is rectified and filtered in a meter detector circuit and then applied to the dBm meter.

A second mixer output is also fed through a ceramic bandpass filter to an audio circuit where audio components of the input signal are detected and amplified. Phone jacks are provided to connect headphones in the circuit for audio monitoring.

The reference oscillator generates a 25 kc square wave and is set to provide an output level that is equivalent to 0dBm at the input connectors. Before voltage measurements are made, the voltmeter sensitivity is calibrated by connecting the reference oscillator output to the voltmeter input circuits and adjusting the second IF amplifier gain (CAL) for a 0 dbm indication. In addition, the high harmonic output of the square wave oscillator provides check points every 25 kc (figures marked in red) from 25 kc to 350 kc for particular frequency range calibration. (See section II. paragraph B.3.)

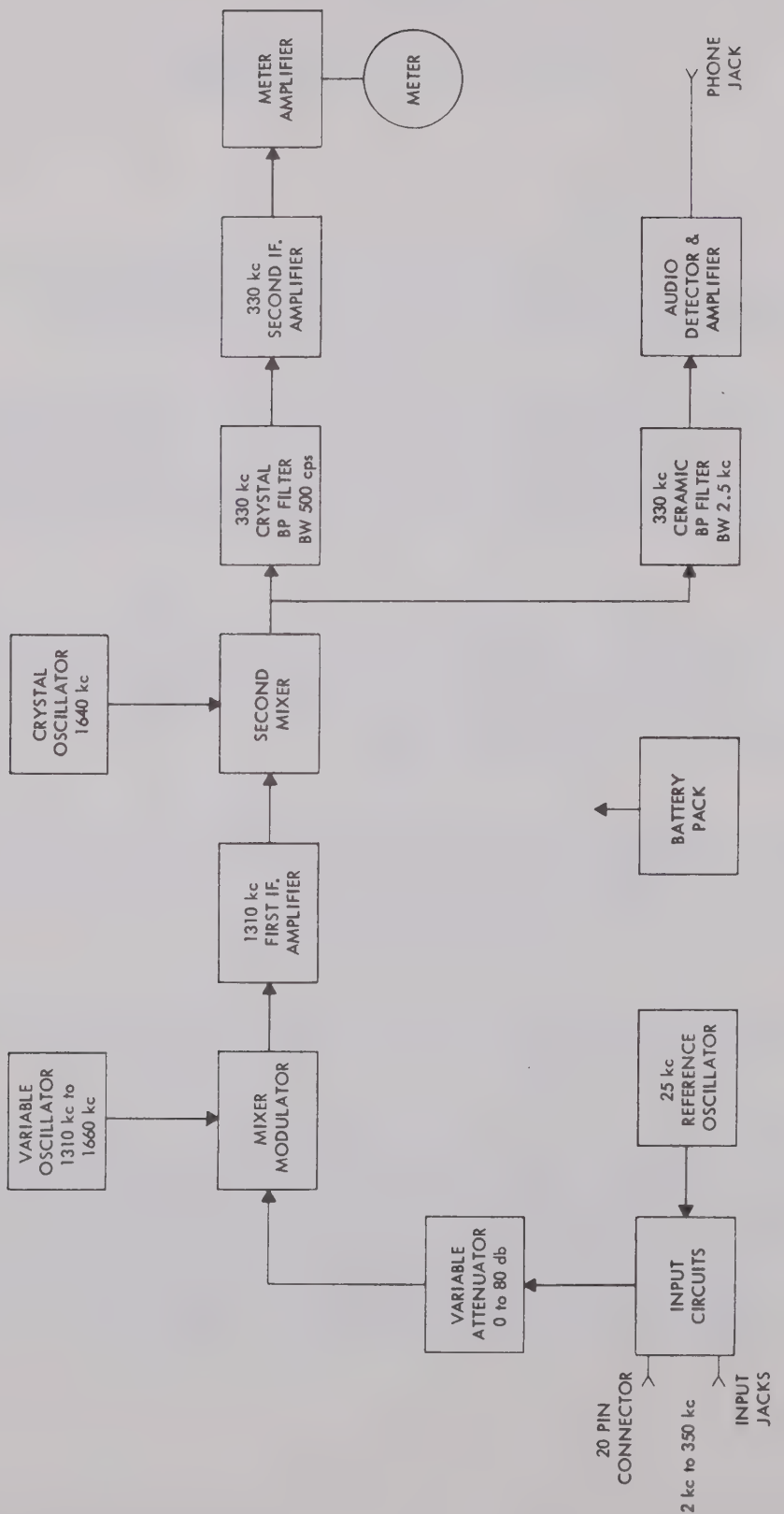

Figure 3-1. KS15538, L5A Functional Block Diagram

When making measurements, the variable attenuator is used to change the voltmeter sensitivity in calibrated steps of 5 dB. For example, assume that a signal level of -19 dBm is applied to the input of a calibrated voltmeter. By adjusting the attenuator to the -20 dB position, the voltmeter sensitivity increases 20 dB, resulting in an indication of +1 dBm. The input level is determined by algebraically adding the meter indication to the attenuator setting: -20 dBm + (+1) dBm = -19 dBm.

B. CIRCUIT DESCRIPTION

1. Input Module A1

The input circuits (Figure 4-7) are composed of three selector switches, an isolation transformer, a filter matching network, a low pass filter, and an 80 dB attenuator. Input signals are applied to either the 20 pin Western Electric connector J1 or to the line input jacks J2, J3, J4. The SELECTOR switch, S3, in conjunction with FUNCTION switch, S1, selects and applies the proper input signal to transformer T1.

In operation, the voltage applied to the low pass filter must be 0.121 volts with 0 dBm at the input connectors. Since 0 dBm corresponds to 0.775 volt on a 600 ohm line and 0.367 volt on a 135 ohm line, compensation is necessary. Isolation transformer T1 and filter matching resistors R13 and R14 serve to compensate for this input signal voltage difference. The primary windings of T1 are connected in parallel for 135 ohm operation and in series for 600 ohm operation. With a 0 dBm input signal, this arrangement results in secondary voltages of 0.232 volts for the parallel connection and 0.245 volts for the series connection. The FUNCTION selector switch inserts the proper resistance between the secondary of transformer T1 and the low pass filter to drop the secondary voltage to 0.121 volt.

After selection, compensation, and matching, the signal is applied to a low pass filter consisting of inductors L1 through L4 and capacitors C1 through C5. The filter, which is constant K derived, has a frequency cutoff of 500 kc and provides 60 dB of rejection to the first IF amplifier frequency (1310 kc).

The variable attenuator, which is used to control the voltmeter sensitivity, consists of switch S2 and resistors R2 through R12. These components are arranged to provide up to 80 dB of attenuation to the input signal in 5 dB steps. When the front panel setting is 0 dB the attenuator provides 60 dB of attenuation. Rotating the attenuator switch to the -60 dB position removes all attenuation from the circuit, thereby increasing the voltmeter sensitivity by 60 dB.

2. Reference Oscillator Module A2

The reference oscillator module (Figure 4-7) is made up of a stable, crystal controlled, temperature compensated oscillator and amplifier that produces a square-topped wave. Zener diode, CR1, provides a regulated supply voltage. Diode CR2 and

CR4 have a temperature characteristic that complements the temperature characteristic of transistors Q1 and Q2. Base bias for Q1 is furnished by the small voltage drop across CR2. One side of the sine wave output of the crystal oscillator is clipped in this circuit. The other side is clipped in the collector circuit of Q2 due to the clamping action of CR3. Thus the output of the reference oscillator appears across R9 as a square-topped wave, stable as to frequency and level. The correct calibrating level is adjusted by R9.

When it is desired to calibrate the voltmeter, the FUNCTION selector switch is set to the CAL position to apply the reference oscillator signal to the low pass filter in the input module. (See para. A. above.) When the FUNCTION selector switch is in any position other than the CAL position, the power supply is disconnected from the reference oscillator collector circuits. This arrangement reduces battery drain when the oscillator is not in use.

3. Mixer Modulator Module A3

The modulator circuits (Figure 4-7) consist of an emitter follower, a common emitter mixer amplifier, and a series balanced modulator. Emitter follower Q1 provides isolation between the attenuator and the mixer amplifier, thereby perserving the attenuator accuracy. The output of the emitter follower is coupled through capacitor C3 to the base of a common emitter mixer amplifier.

The local oscillator signal is injected into the mixer amplifier by the series balanced modulator. The balanced modulator is driven by the variable oscillator and serves as a switching device across R9 through C7. Components of the modulator are arranged to provide equal impedances between each side of the transformer secondary winding and ground. When the diodes,CR1-CR2, conduct the AC impedance across R9 to ground is low. During the other half cycle, the diodes are cut off and present a high AC impedance across R9. Capacitors C8 and C9, and potentiometer R16 are provided to compensate for differences in diode characteristics and to adjust for exact balance.

The local oscillator signal and the input signal are mixed in amplifier Q2. When the modulator diodes conduct, the low AC impedance across R9 increases the gain of amplifier Q1. During diode cut off, AC impedance across R9 is high and the amplifier gain decreases. Thus the mixer gain is varied at the rate of the variable oscillator frequency. Since the AC impedance of the emitter circuit is varying, and not the DC resistance, and since the modulator output is balanced to ground, mixing action will occur with minimum feed-through of the local oscillator signal. The local oscillator signal that appears at the mixer output is down by at least 80 db.

4. Variable Oscillator Module A4

The variable oscillator circuits (Figure 4-7) consist of a Clapp oscillator and an emitter follower. The temperature stabilized oscillator Q1 provides an output level

of 0 dBm with a total variation of 0.25 dB and can be tuned over the frequency range of 1310 kc to 1660 kc. Capacitors C5, C6, C8, C9 and C14 and inductor L2 comprise the frequency determining components. Capacitor C9 is connected to the main tuning control. C8 and C14 are temperature compensating capacitors. L1, C2 in the collector circuit of Q1 is a frequency compensating circuit to increase output level stability.

Capacitor C7 couples the oscillator output to an emitter follower, Q2, that is used for impedance matching and isolation. The emitter follower presents a high impedance to the oscillator and appears as a low impedance driving source for the balanced modulator.

In the collector supply line of the reference oscillator, a decoupling network, L3, C11, C12 and C13, isolates the oscillator from the power supply circuits.

5. First IF Amplifier Module A5

The first IF module circuits (Figure 4-7) consist of a two stage 1310 kc IF amplifier, a second mixer, a 1640 kc second injection oscillator and a three stage resistance coupled amplifier. Common emitter IF amplifiers Q1 and Q2 provide an overall gain of 11 dB and employ both emitter and collector feedback to achieve gain stabilization under temperature and power supply variations. The collector load impedance and the base impedance are resonant tuned circuits. Coupling between stages is by means of coupling capacitors only. The IF output is fed to the base of the second mixer stage Q3 where second conversion takes place.

The local oscillator signal that is used for second conversion is supplied by a 1640 kc crystal controlled oscillator and is applied to the base of the mixer stage Q3. The second mixer produces a 330 kc second IF frequency that is fed to the IF amplifier module A7 and also to the input of Q5. Reduction of 1640 kc signal components in the output circuit of mixer Q3 is achieved by a low pass filter composed of L5 and C19.

Amplifiers Q5, Q6 and Q7 provide amplification for the 330 kc signal and incorporate a ceramic bandpass filter, FL1, to achieve the desired selectivity before the signal is coupled to the audio circuits. Emitter follower amplifier Q7 is coupled to the audio amplifier and detector module A6 through C1, located on module A6.

6. Audio Amplifier and Detector Module A6

The audio amplifier circuits (Figure 4-7) consist of a detector and two audio amplifiers. Common emitter amplifier Q1 and diode CR1 serves as a low level detector. Briefly the action is as follows: During the negative half of the input cycle there is 100% feed back through CR1 so practically no output signal will appear across the collector load resistor R14. When the input signal is positive going, the amplification is normal since there is no feed back through CR1 and an output signal will be developed. C4, C5 and R6 make up a low pass filter to remove the IF components. Since the negative portion of the input signal is not developed in the output and the IF components are

filtered out, the audio component of the signal will remain as the output developed across R14.

The detector output is taken from gain control R14 and applied to the two stage direct-coupled amplifier, Q2, Q3. The output impedance of Q3 is low, about 75 ohms, due to the large feedback factor provided by C7. C10 gives a high frequency roll-off which prevents instability. R7, R10 form the bias network for the base of Q2. Headphones are connected when audio monitoring is desired and serve as the collector load impedance for Q3. Collector voltage is connected to the A6 module and to the two resistance coupled stages of A5B module only when headphones are plugged into the phone jacks. This arrangement reduces battery drain when audio monitoring is not used.

7. Second IF Amplifier Module A7

The second IF amplifier (Figure 4-7) consists of a 330 kc amplifier and a narrow bandpass crystal filter. Before amplification, the 330 kc IF signal is applied to a 330 kc crystal filter that provides a 3 dB bandwidth of 500 cycles. This filter determines the overall selectivity. Three stages of IF amplification are provided by Q1, Q2 and Q3. Each amplifier uses a single tuned tank circuit, emitter feedback and capacitive coupling. In addition, amplifier Q3 has a potentiometer in the emitter circuit for CAL adjustment. The overall gain, including input filter and crystal filter losses, is adjustable from +25 to +55 dB.

The collector supply line is decoupled by inductors L4, L5 and L6 and capacitors C12, C13 and C14 to prevent interaction between IF amplifier stages. The output is coupled by capacitor C11 to the meter amplifier A8.

8. Meter Amplifier Module A8

The meter amplifier is a two stage feedback amplifier employing a large amount of negative feedback. The meter rectifier is a bridge type, which with the large feedback factor of the amplifier, provides a meter indication which is very linear over its full range. The meter has a 200 microampere movement and is calibrated in dBm and volts. The dBm readings apply to both 600 ohm and 135 ohm line measurement, but the voltage scale applies to measurements in the 600 ohm position only. The Meter Module, A10, stabilizes the meter readings.

9. Power Supply Circuits

The power supply circuit consists of six 1.5 volt zinc-carbon size D cells connected in series to provide a nominal supply voltage of 9 volts. Since the voltmeter circuits use pnp transistors, requiring a negative collector voltage, the positive terminal of the battery is grounded. The negative battery terminal is connected to the arm of FUNCTION selector switch, S1C.

When the selector switch is in the BATT position, the switch connects the power supply to the meter through resistor, R11. The circuit is completed through CR1, R9 and R10 to ground. In this switch position the INPUT jacks are disconnected, but the instrument is turned on, so the true state of the batteries is indicated. When the FUNCTION switch is in either the 135 ohm or the 600 ohm position, the battery is connected to all modules except the reference oscillator. In the CAL position, the battery is connected to all modules of the voltmeter. The battery is disconnected from the voltmeter circuits in the OFF position.

SECTION IV
CALIBRATION AND MAINTENANCE

A. CALIBRATION

1. Reference Oscillator

In the event of parts replacement or normal aging of components recalibration may be desireable. This is accomplished by comparing the reference oscillator output level to a known external source. Before proceeding with step a., refer to paragraph B.3.a., connect the signal generator and VTVM to the Frequency Selective Voltmeter as shown in Figure 4-1 and proceed as follows:

a. Adjust Frequency Selective Voltmeter controls as follows:

FUNCTION	600 ohms
SELECTOR	INPUT
ATTENUATOR	0 CAL
MAIN TUNING	25 kc

b. Adjust signal generator frequency to 25 kc.

c. Adjust signal generator output for 0 dBm as measured on VTVM.

d. Adjust FINE tuning control for maximum indication on dBm meter of Frequency Selective Voltmeter.

e. Adjust MAIN TUNING index control until index pointer is directly below the 25 kc mark on main tuning dial face.

f. Adjust CAL GAIN control until dBm meter indicates 0 dBm.

g. Set FUNCTION selector switch to CAL position.

h. At module A2 adjust Level potentiometer, R9, (Figure 4-4) until meter indicates 0 dB. The voltmeter is now calibrated and ready for use.

i. In order to maintain the inherent accuracy of the Voltmeter the Balanced Modulator should be checked periodically. Procedure for this adjustment is given in paragraph C.2.

B. TROUBLE SHOOTING

1. General Outline

The trouble shooting procedures consist of three parts: isolation to a particular module, module trouble shooting and transistor voltage checks. These procedures are presented in tables. Table 4-1 provides a step by step procedure to isolate trouble to a particular module or circuit. When the trouble has been isolated to a particular module, follow the instructions given by the appropriate module trouble shooting table (Tables 4-2 through 4-10). These tables provide step by step procedures to perform trouble shooting at the module level. When the trouble has been isolated to a particular transistor or stage, check the voltages given in Table 4-11. Refer to Figures 4-2, 4-3 and 4-4 for module locations.

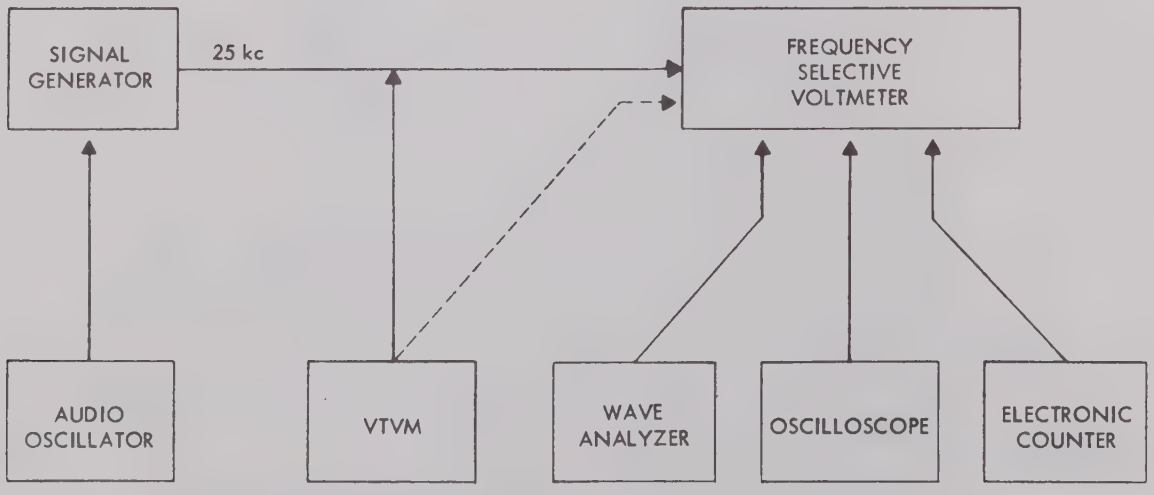

Figure 4-1. Trouble Shooting Test Setup

2. Gains and Signal Levels

To aid in trouble shooting, Figure 4-6 illustrates the stages that comprise the Frequency Selective Voltmeter and provides gain figures and signal levels. Figure 4-7 is the schematic wiring diagram.

3. Procedures

Before proceeding with Step 1 in Table 4-1, connect the voltmeter in the test setup shown in Figure 4-1. Signal generator to be connected to INPUT jacks.

a. Test Equipment Required

(1) Multimeter, Simpson 260 or equivalent

(2) AC VTVM, HP 400L or equivalent

(3) Signal generator, General Radio 1001 A or equivalent

(4) Wave analyzer, Sierra 128A, 126A or equivalent

(5) Audio oscillator, HP 200C, or equivalent

(6) Counter, HP 524C or equivalent

(7) Oscilloscope, Tektronix 533 or equivalent

(8) DC VTVM, HP 412A, or equivalent

(9) Sierra Model 219C In-Circuit Transistor Tester, or equivalent

b. Set the Frequency Selective Voltmeter controls as follows:

FUNCTION	600 ohms
SELECTOR	INPUT
ATTENUATOR	0 CAL
MAIN TUNING	25 kc

c. Adjust the signal generator for a 0 dBm 25 kc signal output as read on VTVM.

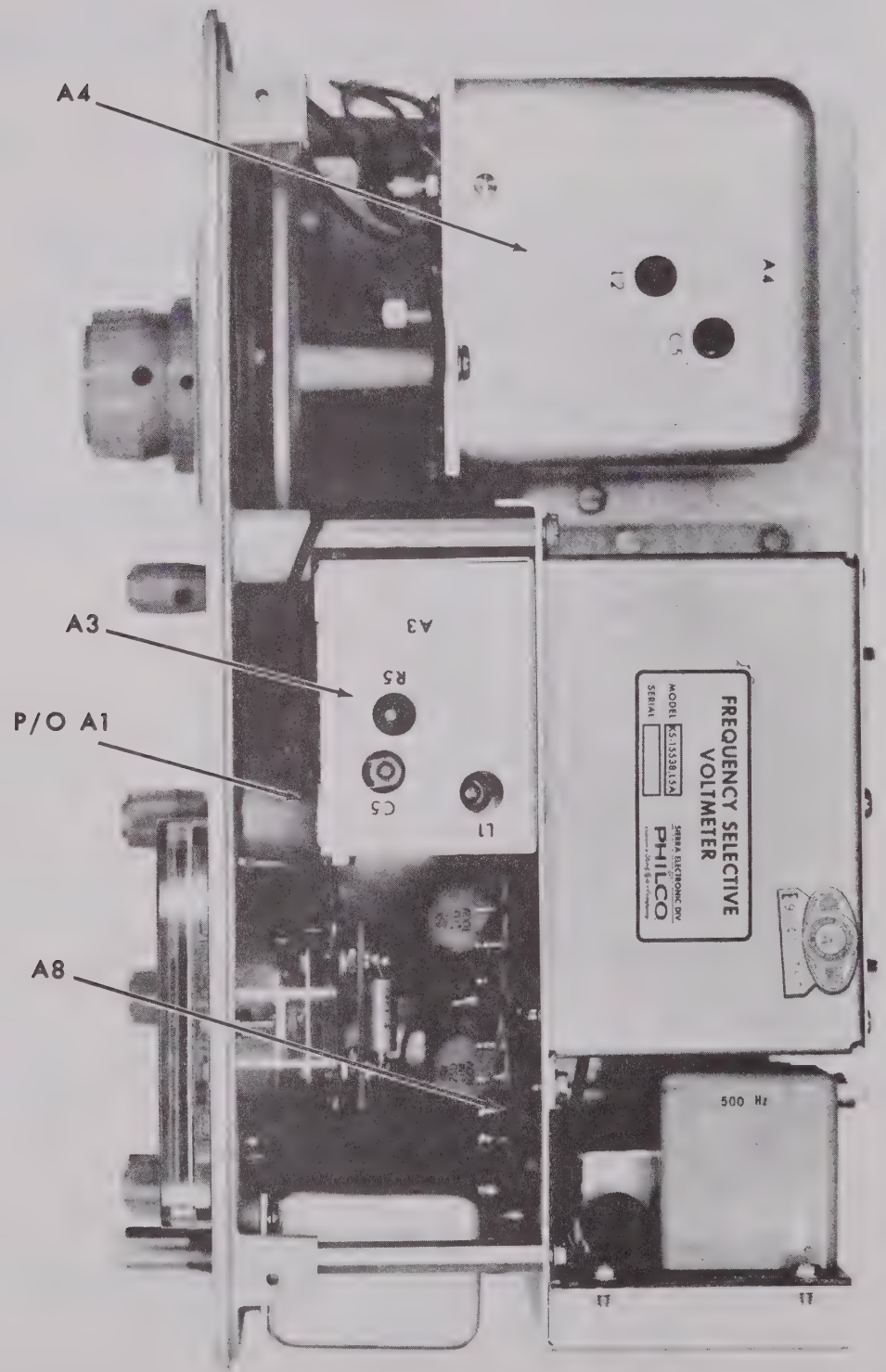

 Figure 4-2. KS15538, L5A Module Location, Top View

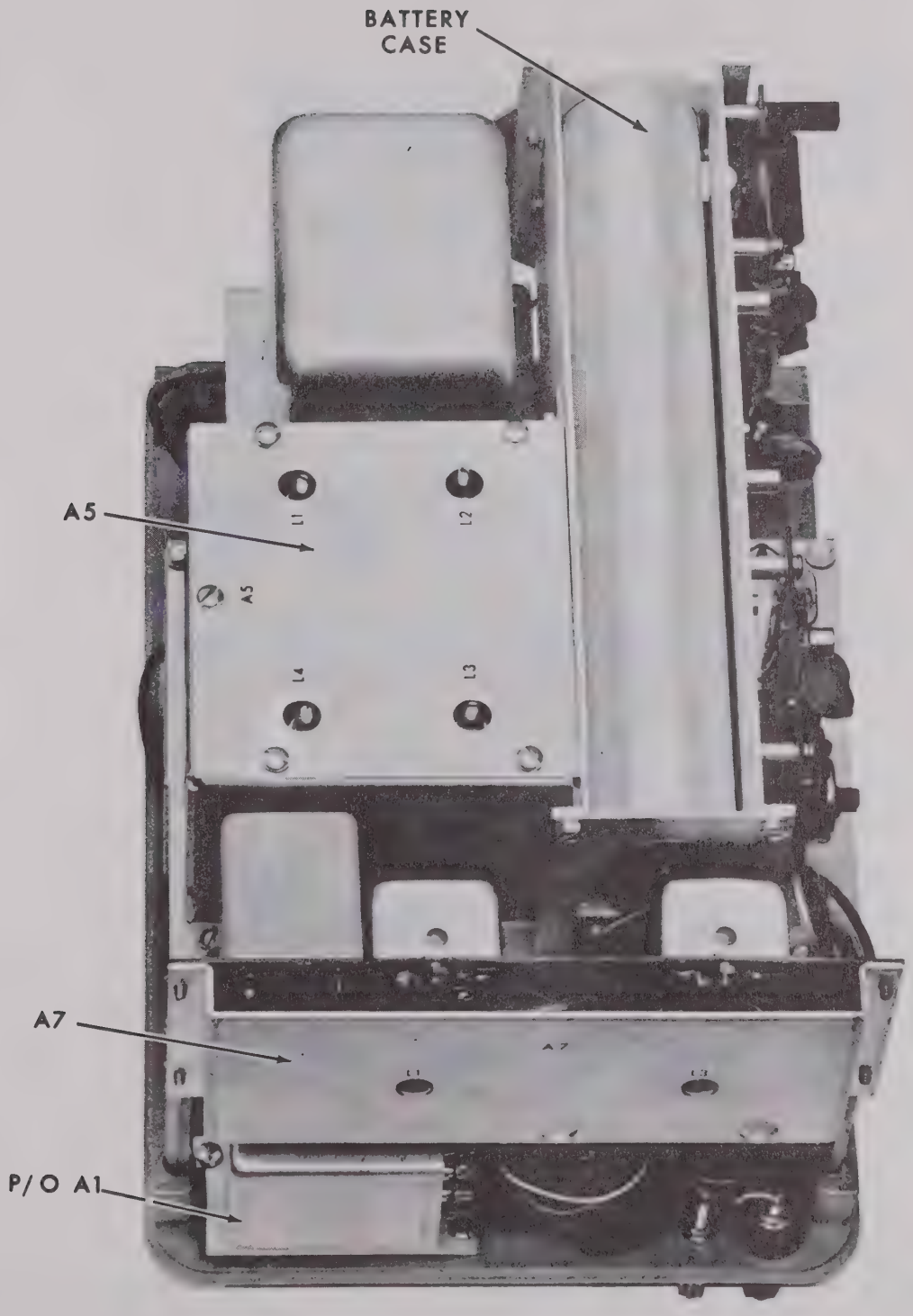

Figure 4-3. KS15538, L5A Module Location, Rear View

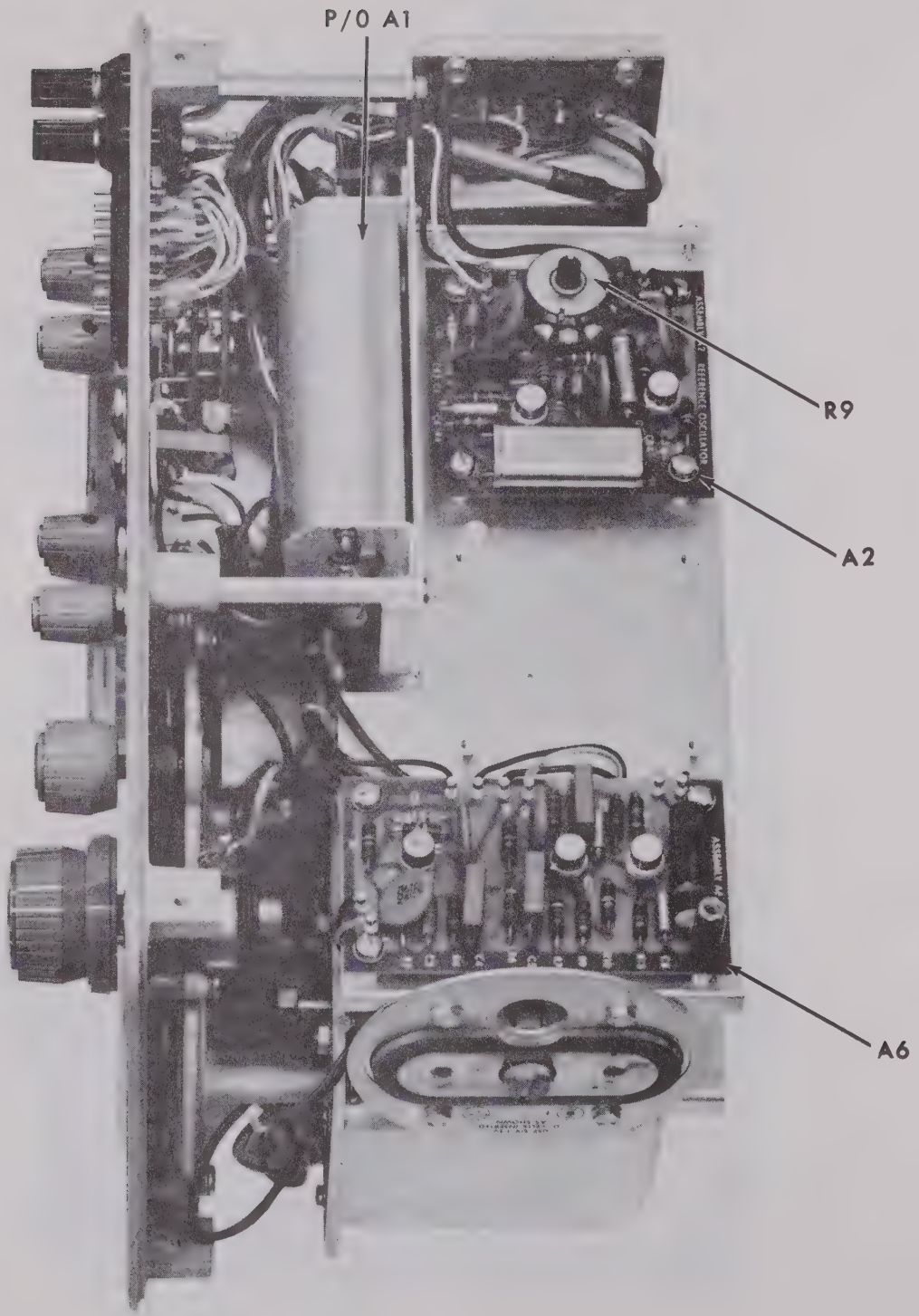

Figure 4-4. KS15538, L5A Module Location, Bottom View

TABLE 4-1

MODULE TROUBLE ISOLATION

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place FUNCTION switch in BATT position.	Meter reads within green band.	Replace batteries. Trouble is in battery circuits. See Table 4-2.
2.	Place FUNCTION switch to 600 ohms. Connect VTVM to C1 on module A3.	VTVM indicates -76 dBm.	Trouble is in input module A1. See Table 4-3.
3.	Place FUNCTION switch to CAL. Connect VTVM to arm of R9 in module A2.	VTVM indicates -16 dBm.	Trouble is in reference oscillator module A2. See Table 4-4.
4.	Place FUNCTION switch to 600 ohms. Connect VTVM to C10 on module A4.	VTVM indicates 0 dBm.	Trouble is in variable oscillator module A4. See Table 4-5.
5.	Place ATTENUATOR switch to 0 dBm and selector to INPUT. Connect a wave analyzer to C6 on module A3.	Wave analyzer indicates a -96 dBm, 1310 kc signal.	Trouble is in mixer-modulator module A3. See Table 4-6.
6.	Connect wave analyzer to C1 on module A7.	Wave analyzer indicates -62 dBm. 1310 kc signal.	Trouble is in first IF module A5. See Table 4-7.
7.	Connect VTVM to C11 on module A7. Rotate CAL control until VTVM indicates -24 dBm.	VTVM indicates -24 dBm.	Trouble is in second IF module A7. See Table 4-8.
8.	Connect VTVM to collector of Q2 on module A8.	VTVM indicates -4 dBm.	Trouble is in meter detector module A8. See Table 4-9.

*Some variation from these values is to be expected in different instruments.

TABLE 4-1 (Continued)

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
9.	Set ATTENUATOR to 0 dBm. Connect VTVM to C1 on module A6. Set signal generator for 1000 cycle 50% AM. modulation.	VTVM indicates -48 dBm.	Trouble is in first IF module A5. See Table 4-7.
10.	Connect VTVM to collector of Q3 on module A6. Plug high impedance head phones into PHONES jack. If phones are not available, use 1K resistor.	VTVM indicates +6 dBm.	Trouble is in audio amplifier and detector module A6. See Table 4-10.

TABLE 4-2

BATTERY CIRCUIT TROUBLE SHOOTING

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1.	Connect a multimeter to negative side of battery pack.	METER indicates -8.3 volts to -9 volts DC.	Check contacts in battery pack. Check battery.
2.	Place FUNCTION switch to BATT position. Connect multimeter to pin 1 of switch S1C.	METER indicates -8.3 volts to -9 volts DC.	Check FUNCTION selector switch S1C in input module.
3.	Place FUNCTION switch to 600 or 135 ohm position. Connect a multimeter to pin 4 of switch S1C.	METER indicates -8.3 volts to -9 volts DC.	Check FUNCTION selector switch S1C in input module.

TABLE 4-3

A1 INPUT MODULE TROUBLE SHOOTING
(With 25 kc 0 dbm signal to INPUT jacks)

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1.	Place FUNCTION switch to 600 ohms. Connect VTVM to pin 9 of FUNCTION switch S1A.	VTVM indicates .121 volts AC.	Check capacitor C6, transformer T1, switch S1 and resistors R13 and R14.
2.	Connect VTVM to output pin of low-pass filter.	VTVM indicates .121 volts AC.	Check low-pass filter.
3.	Connect VTVM to pin 14 of ATTENUATOR switch S2A. Rotate FUNCTION selector switch over entire attenuation range in 5 dB steps.	VTVM indicates voltage change in 5dB steps.	Check resistors R1 through R12 and switch S2.

TABLE 4-4

A2 REFERENCE OSCILLATOR TROUBLE SHOOTING

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place FUNCTION switch to CAL. Connector multimeter to junction of CR1 and CR2.	METER indicates -6.2 volts DC.	Check resistor R1 and diode CR1.
2.	Connect oscilloscope to collector of Q1.	Oscilloscope displays 4 volt peak, 25 kc half sine wave.	Check transistor Q1. See voltage charts in Table 4-11
3.	Connect oscilloscope to emitter of Q2.	Oscilloscope displays 5.3 volt peak-to-peak 25 kc square wave.	Check transistor Q2. See voltage charts in Table 4-11.

*Some variation from these values is to be expected in different instruments.

TABLE 4-5

A4 VARIABLE OSCILLOATOR TROUBLE SHOOTING

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place FUNCTION switch to 600 ohms. Connect a multimeter to collector of Q2 in module A4.	METER indicates -8.3 volts to -9 volts DC.	Check inductor L3, and capacitors C12, and C13.
2.	Connect oscilloscope to collector of Q1.	Oscilloscope displays 2.2 volt peak-to-peak, 1335 kc signal.	Check transistor Q1. See voltage charts in Table 4-11.
3.	Connect oscilloscope to emitter of Q2.	Oscilloscope displays 2.2 volt peak-to-peak, 1335 kc signal.	Check transistor Q2. See voltage charts in Table 4-11.
4.	If electronic counter is available, connect it to collector of Q1. Rotate MAIN TUNING dial control over entire frequency range.	Counter indicates changing frequency from 1310 kc to 1660 kc.	Replace Q1. Perform reference oscillator alignment contained in paragraph C.2.

TABLE 4-6

A3 MIXER - MODULATOR MODULE TROUBLE SHOOTING
(With 25 kc 0 dbm signal at INPUT jacks)
(SELECTOR to INPUT, FUNCTION to 60 ohms)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place ATTENUATOR to 0dB . Connector wave analyzer between pins 3 and 4 of transformer T1. Set MAIN TUNING dial control to 25 kc.	Wave analyzer indicates 0 dBm, 1335 kc signal.	Check transformer T1.

*Some variation from these values is to be expected in different instruments.

TABLE 4-6 (Continued)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
2.	Connect wave analyzer to emitter of Q1.	Wave analyzer indicates -76 dBm, 25 kc signal.	Check transistor Q1. See voltage charts in Table 4-11.
3.	Connect wave analyzer to collector of Q2. Tune wave analyzer to 1310 kc.	Wave analyzer indicates -96 dBm, 1310 kc signal.	Check diodes CR1 and CR2. Check transistor Q2. See voltage charts in Table 4-11.
4.	Disconnect 25 kc input signal. Connect wave analyzer to collector of Q2. Tune wave analyzer to 1335 kc.	Wave analyzer indicates at least -80 dBm.	Perform balanced modulator adjustment per paragraph C. 2. Check diodes CR1 CR2.

TABLE 4-7

A5 FIRST IF AMPLIFIER MODULE TROUBLE SHOOTING
(With 25 kc 0 dbm signal at INPUT jacks)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Set FUNCTION switch to 600 ohms ATTENUATOR to 0 dBm, SELECTOR to INPUT. Connect wave analyzer to base Q2, tune to 1310 kc.	Wave analyzer indicates -85 dBm.	Perform first if. amplifier alignment contained in paragragraph C.1. Check transistor Q1. See voltage charts in Table 4-11.
2.	Connect wave analyzer to base of Q3.	Wave analyzer indicates -70.5 dBm.	Perform first if. amplifier alignment contained in paragraph C.1. Check transistor Q2. See voltage charts in Table 4-11.
3.	Connect wave analyzer to collector of Q3.	Wave analyzer indicates -62 dBm.	Check transistor Q3. See voltage charts in Table 4-11.

*Some variation from these values is to be expected in different instruments.

TABLE 4-7 (Continued)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
4.	Connect wave analyzer to base of Q3. Tune to 1620 kc.	Wave analyzer indicates -18 dBm.	Check transistor Q4. See voltage charts in Table 4-11.
5.	Connect wave analyzer to input of FL1. Tune to 330 kc.	Wave analyzer indicates -56 dBm.	Check transistor Q5. See voltage charts in Table 4-11.
6.	Connect wave analyzer to output of FL1.	Indicates -59 dBm.	Check ceramic bandpass filter FL1.
7.	Connect wave analyzer to emitter of Q7.	Wave analyzer indicates -48 dBm.	Check transistor Q6 and Q7. See voltage charts in Table 4-11.

TABLE 4-8

A7 SECOND IF AMPLIFIER MODULE TROUBLE SHOOTING

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place FUNCTION switch to 600 ohms. Set ATTENUATOR to 0dBm. SELECTOR to INPUT. Connect VTVM to output of crystal filter FL1.	VTVM indicates -69 dBm.	Check FL1.
2.	Connect VTVM to C5.	VTVM indicates -50 dBm.	Perform second if. amplifier alignment contained in paragraph C.3. Check transistor Q1. See voltage charts in Table 4-11.
3.	Connect VTVM to C8.	VTVM indicates -41 dBm.	Perform second if. amplifier alignment contined in paragraph C.3. Check transistor Q2. See voltage charts in Table 4-11.

*Some variation from these values is to be expected in different instruments.

TABLE 4-8 (Continued)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
4.	Connect VTVM to C11.	VTVM indicates -24 dBm. (Depends on CAL setting, see step 5.)	Perform second if. amplifier alignment contained in paragraph C.3.
5.	Rotate CAL control over entire range. Reset to -24 dBm.	VTVM indicates -39dBm. to -9 dBm	Check R13, C10, R12. Check transistor Q3. See voltage charts in Table 4-11.

TABLE 4-9

A8 METER AMPLIFIER MODULE TROUBLE SHOOTING

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Connect VTVM to collector of Q2.	VTVM indicates -4 dBm and meter indicates 0 dBm.	Check Q1, Q2. See voltage charts in Table 4-11.

TABLE 4-10

A6 AUDIO AMPLIFIER AND DETECTOR MODULE
TROUBLE SHOOTING
(25 kc, 0 dbm, 50% modulated 1000 cps signal at INPUT jacks.)
(Use HP 200C to modulate GR 1001A)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
1.	Place ATTENUATOR switch to 0 dB. Place FUNCTION switch to 600 ohms. SELECTOR to INPUT. Connect VTVM to collector of Q1.	VTVM indicates -20 dBm.	Check transistor Q1. See voltage chart in Table 4-11.

*Some variation from these values is to be expected in different instruments.

TABLE 4-10 (Continued)

STEP	PROCEDURE	NORMAL INDICATION*	IF INDICATION IS ABNORMAL
2.	Connect VTVM to C9. Plug headset into PHONES jack. If headset is not available use 1000 ohm resistor. AUDIO GAIN maximum.	VTVM indicates +6 dBm. Headset reproduces 1000 cycle tone.	Check PHONES jack. Check transistors Q2, Q3. See voltage chart Table 4-11

*Some variation from these values is to be expected in different instruments.

4. Typical Transistor Trouble Shooting

The following procedures present typical trouble shooting for a pnp common emitter amplifier stage. See Table 4-11 for typical transistor voltages.

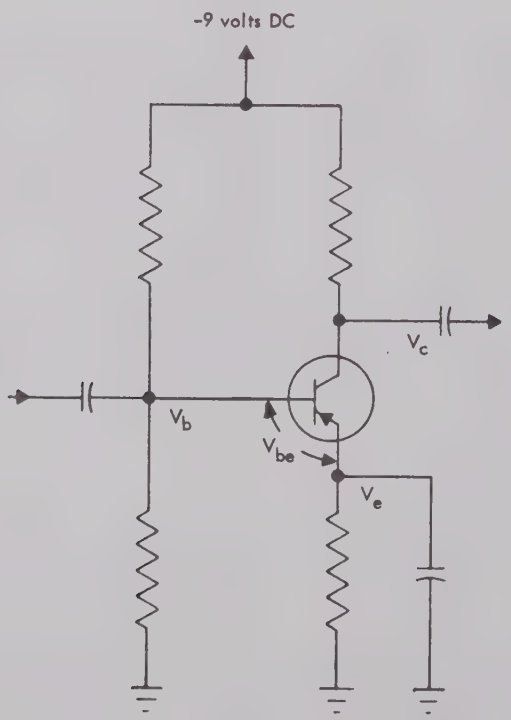

Figure 4-5. Typical Transistor Trouble Shooting Schematic

a. Check V_c (Figure 4-5). If indication is zero volts, the transistor collector or emitter junction is shorted. If indication is same as collector supply voltage, the emitter or collector junction is open. (Collector of emitter follower will ordinarily be at the supply voltage, however.)

b. Check V_{be} (Figure 4-5). If indication is greater than normal, emitter junction is open. If indication is zero volts, the emitter junction is shorted. V_{be} is the difference between base and emitter voltages. ($V_b - V_e = V_{be}$).

c. Alternate method: Instead of voltage checks use "in circuit" transistor tester to check transistors.

TABLE 4-11
TRANSISTOR VOLTAGE MEASUREMENTS*

MODULE	TRANSISTOR	EMITTER	BASE	COLLECTOR
		v dc	v dc	v dc
A2	Q1	-0.50	-0.70	-3.0
	Q2	-0.70	-0.90	-3.1
A3	Q1	-7.75	-7.95	-9.0
	Q2	-0.72	-0.98	-9.0
A4	Q1	-4.0	-4.2	-6.5
	Q2	-4.0	-4.2	-9.0
A5	Q1	-0.42	-0.67	-4.4
	Q2	-0.42	-0.67	-4.4
	Q3	-0.60	-0.81	-5.8
	Q4	-0.65	-0.85	-4.1
	Q5	-4.0	-4.2	-7.5
	Q6	-2.2	-2.4	-4.4
	Q7	-4.6	-4.8	-9.0
A6	Q1	-2.1	-2.3	-4.0
	Q2	-1.6	-1.8	-3.1
	Q3	-2.9	-3.1	-5.0
A7	Q1	-0.95	-1.15	-9.0
	Q2	-1.25	-1.40	-9.0
	Q3	-4.6	-4.8	-9.0

*Taken with a VTVM. Readings should be within ±20%. Voltage is measured between transistor electrode and chassis.

TABLE 4-11 (Continued)

MODULE	TRANSISTOR	EMITTER	BASE	COLLECTOR
A8	Q1	-0.55	-0.75	-2.1
	Q2	-1.8	-2.0	-5.1

C. ALIGNMENT AND ADJUSTMENTS

1. 1310 KC IF Amplifier Alignment

The alignment of the 1310 kc IF amplifier is performed by using the internal reference oscillator as a signal source. To align the 1310 kc IF amplifier proceed as follows:

a. Set voltmeter controls as follows

FUNCTION	CAL
ATTENUATOR	0 CAL
MAIN TUNING	25 kc

b. Adjust CAL control until dBm reading is in upper half of scale.

c. Using a non-metallic tuning tool, adjust L1, L2, L3, L4, for maximum indication on dBm meter.

2. Balanced Modulator Adjustment

This procedure adjusts the balanced modulator so that a minimum of local oscillator signal appears at the mixer output. To adjust the balanced modulator, proceed as follows:

a. Set voltmeter controls as follows: (No signal to be applied to input).

FUNCTION	600 ohms
MAIN TUNING	3 kc

b. Connect VTVM (HP400L or equivalent) to C6 on modulator module, A3.

c. Adjust R15 for minimum 1313 kc output as indicated on VTVM.

d. Adjust C8 and C9 for minimum 1313 kc output.

e. Repeat steps c. and d. until VTVM indicates null.

3. 330 KC IF Amplifier Alignment

The alignment of the 330 kc IF amplifier is performed by using the internal reference oscillator as a signal source. To align the 330 kc IF amplifier, proceed as follows:

a. Set voltmeter controls as follows:

FUNCTION	CAL
ATTENUATOR	0 CAL
MAIN TUNING	25 kc

b. Adjust CAL control until dBm reading is in upper half of scale.

c. Using a non-metallic tuning tool, adjust L1, L2, L3 for maximum inciation on dBm meter.

4. Variable Oscillator Alignment

The alignment of the reference oscillator adjusts the oscillator tracking from 25 kc to 325 kc.

a. Connect electronic counter to output of variable oscillator at C10.

b. Set MAIN TUNING index to mid-range.

c. Rotate MAIN TUNING dial to 0.

d. Check that capacitor plates (C9) are fully meshed, ±1/16 inch.

e. Rotate MAIN TUNING dial to 25 kc.

f. Adjust inductor, L2, until electronic counter indicates 1335 kc.

g. Rotate MAIN TUNING dial to 325 kc.

h. Adjust capacitor C5 until electronic counter indicates 1635 kc.

i. Repeat steps e. through h. until oscillator tracks over entire tuning range ±1.0 kc. If tracking is not within tolerance, loosen setscrew holding capacitor shaft to tuning mechanism, readjust slightly and repeat steps e. through h.

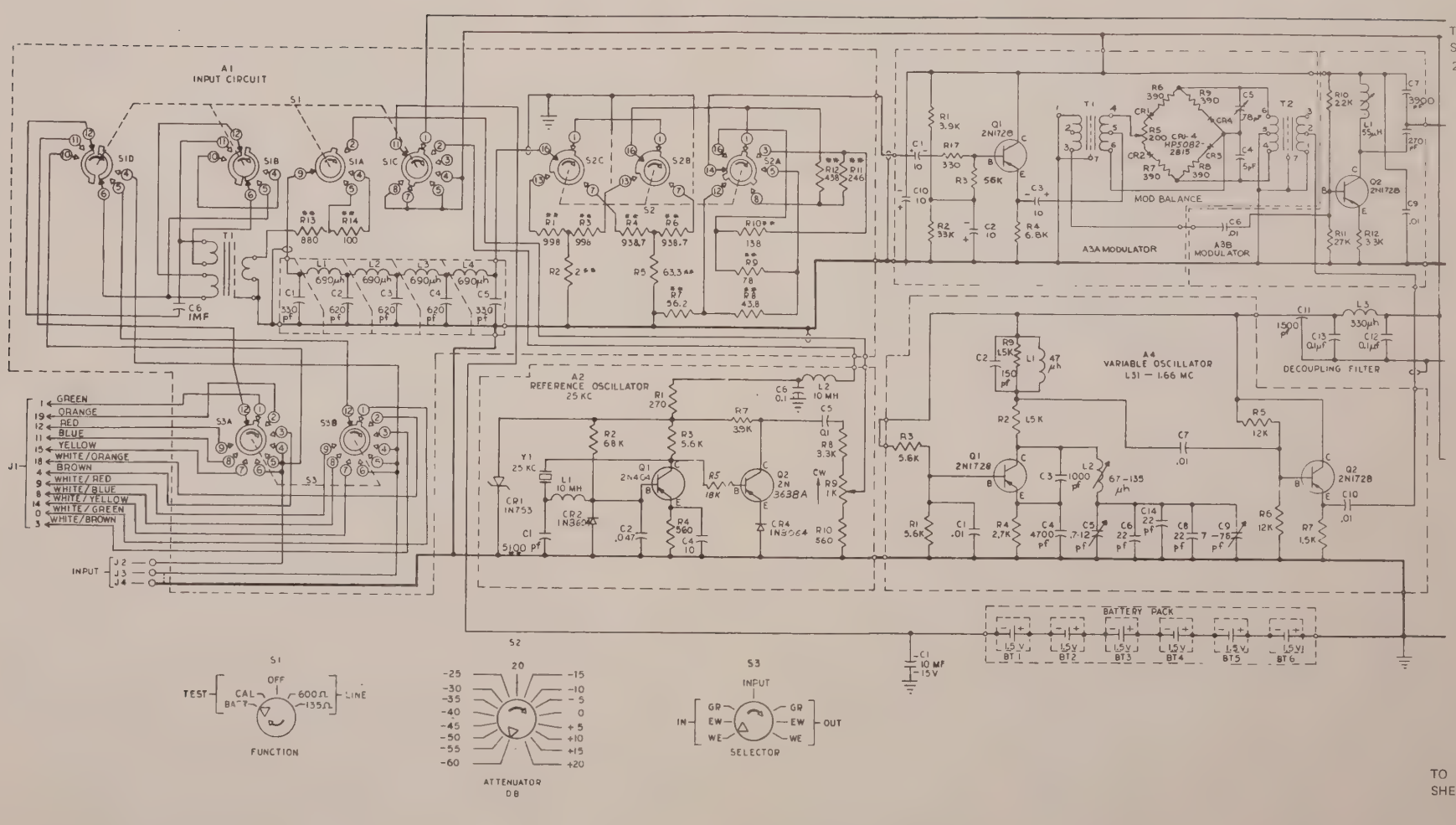

Figure 4-7. KS15538, L5A Schematic Diagram
(Sheet 1 of 2)

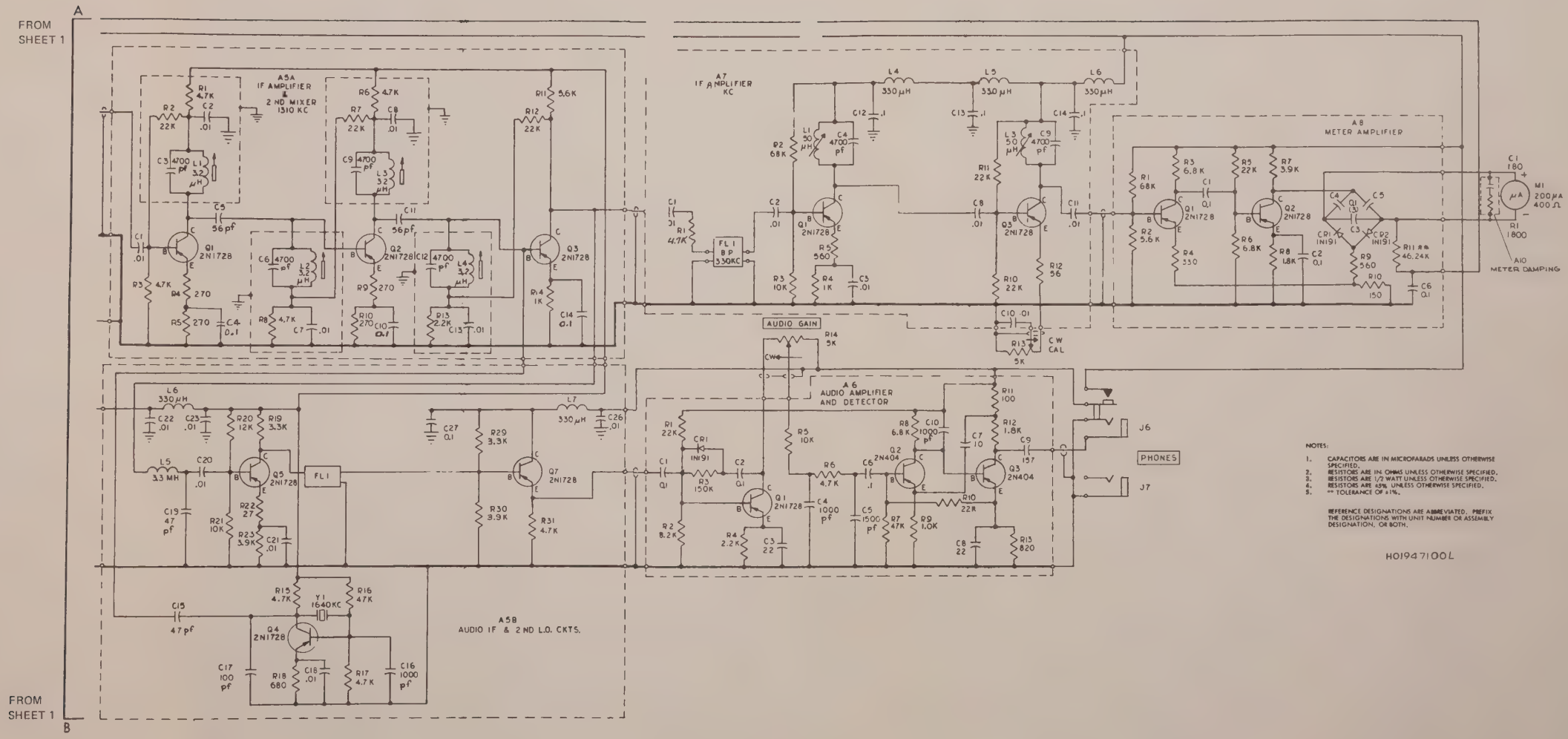
FROM SHEET 1
A
B
FROM SHEET 1
A5A IF AMPLIFIER & 2ND MIXER 1310 KC
A5B AUDIO IF & 2ND L.O. CKTS.
A7 IF AMPLIFIER KC
FL1 BP 330KC
A8 METER AMPLIFIER
M1 200μA 400Ω
A10 METER DAMPING
AUDIO GAIN
CW CAL
A6 AUDIO AMPLIFIER AND DETECTOR
PHONES
J6
J7
Y1 1640KC
NOTES:
1. CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
3. RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED.
4. RESISTORS ARE ±5% UNLESS OTHERWISE SPECIFIED.
5. ** TOLERANCE OF ±1%.
REFERENCE DESIGNATIONS ARE ABBREVIATED. PREFIX THE DESIGNATIONS WITH UNIT NUMBER OR ASSEMBLY DESIGNATION, OR BOTH.
H01947100L

Figure 4-7. KS15538, L5A Schematic Diagram (Sheet 2 of 2)

SECTION V

REPLACEABLE PARTS LIST

PARTS REPLACEMENT

Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory.

When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference and Commercial Description.
3. Name, Model and Serial Number of the Instrument.

Parts for this instrument, or further service information may be obtained from:

SIERRA ELECTRONIC DIVISION
Philco Corporation
3885 Bohannon Drive
Menlo Park, California 94025

Telephone (415) 322-7222
TWX 910-373-1282

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A1 INPUT MODULE				
C1	CAPACITOR, Silver Mica 330 pF ±5% 500 VDCW	902000331	Elmenco	CM-15-E-331J	2
C2	CAPACITOR, Silver Mica 620 pF ±5% 300 VDCW	902000621	Elmenco	CM-20-D-621J	3
C3	Same as C2				
C4	Same as C2				
C5	Same as C1				
C6	CAPACITOR, Tubular 1 mf ±5% 600 WVDC or equiv.	901060105	Goodall	X663F	1
L1	INDUCTOR, 690 µH ±5%	148391000	Sierra	SS-14839-1	4
L2	Same as L1				
L3	Same as L1				
L4	Same as L1				
R1	RESISTOR, Carbon Film 998 ohm ±1% 1/2Watt	907400104	Electra	DC-1/2A	2
R2	RESISTOR, Wirewound 2 ohm ±1% 1/2 Watt	906100015	Gen.Resis.Inc.	HA02H	1
R3	Same as R1				
R4	RESISTOR, Carbon Film 938.7 ohm ±1% 1/2 Watt	907400105	Electra	DC-1/2A	2
R5	RESISTOR, Carbon Film 63.3 ohm ±1% 1/2 Watt	907400106	Electra	DC-1/2A	1
R6	Same as R4				
R7	RESISTOR, Carbon Film 56.2 ohm ±1% 1/2 Watt	907400107	Electra	DC-1/2A	1
R8	RESISTOR, Carbon Film 43.8 ohm ±1% 1/2 Watt	907400108	Electra	DC-1/2A	1
R9	RESISTOR, Carbon Film 78.0 ohm ±1% 1/2 Watt	907400109	Electra	DC-1/2A	1
R10	RESISTOR, Carbon Film 138.0 ohm ±1% 1/2 Watt	907400110	Electra	DC-1/2A	1
R11	RESISTOR, Carbon Film 246 ohm ±1% 1/2 Watt	907400111	Electra	DC-1/2A	1
R12	RESISTOR, Carbon Film 438 ohm ±1% 1/2 Watt	907400112	Electra	DC-1/2A	1
R13	RESISTOR, Carbon Film 880 ohm ±1% 1/2 Watt	907400113	Electra	DC-1/2A	1
R14	RESISTOR, Carbon Film 100 ohm ±1% 1/2 Watt	907400114	Electra	DC-1/2A	1
S(1)	SWITCH, 5 Position, 4 Sect., Shorting	911200071	Sierra	SS-14826-1	1
S(2)	SWITCH, 17 Position, 3 Sect., Shorting	911200082	Sierra	SS-14825-1-D	1
S(3)	SWITCH, 12 Position	911200084	Sierra	SS-14827-1	1
T1	TRANSFORMER	125233000	Sierra	SP-12523-3	1
J1	CONNECTOR, 20 Terminals	914800003	Cinch	213-20-00-108	1
J2	BINDING POST, Insulated	915200012	Gen. Radio	938-C	2
J3	Same as J2				
J4	BINDING POST, Uninsulated	915200013	Gen. Radio	938A	1
	SHORT LINK	915200007	Gen. Radio	938-L	1
	A2 REFERENCE OSCILLATOR MODULE				
C1	CAPACITOR, S.M. 5700 pF ±1%, 300 WVDC	901910512	Elmenco	DM-19-F-512F	1
C2	CAPACITOR, Metalized Paper, .047 mf ±10%, 100 WVDC	902400473	Sprague	196P47391S2	1
C3	CAPACITOR, Disc, 0.1 pF ±20%, 100 WVDC	901410104	Sprague	33C41B6	3
C4	CAPACITOR, Tantalum, 10µF, 15 WVDC	902740106	T. I.	SCM-106-BP015D4	1
C5	Same as C3				
C6	Same as C3				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A2 REFERENCE OSCILLATOR MODULE (Continued)				
CR1	DIODE, Zener Type 1N753 (6.2 Volts)	910500001	T. I.	1N753	1
CR2	DIODE, Silicon Type 1N3604	910500010	Raytheon	1N3604	2
CR3	Not Used				
CR4	Same as CR2				
L1	COIL, 10 mH ±2%	909000117	J.W. Miller	70F102A1	2
L2	Same as L1				
R1	RESISTOR, Composition, 270 ohm ±5%, 1/2W	905000271	AB	EB	1
R2	RESISTOR, Composition, 68,000 ohm ±5%, 1/2W	905000683	AB	EB	1
R3	RESISTOR, Composition, 5,600 ohm ±5%, 1/2W	905000562	AB	EB	1
R4	RESISTOR, Composition, 560 ohm ±10%, 1/2W	905000561	AB	EB	1
R5	RESISTOR, Composition, 100,000 ohm ±10%, 1/2W	905000104	AB	EB	1
R6	RESISTOR, Composition, 10,000 ohm ±10%, 1/2W	905000103	AB	EB	1
R7	RESISTOR, Composition, 3,900 ohm ±10%, 1/2W	905000392	AB	EB	1
R8	RESISTOR, Composition, 3.3K ohm ±5%, 1/2W	905000332	AB	EB	1
R9	POTENTIOMETER, PC Mtg. 1000 ohm	907900101	Stackpole	LH 61	1
R10	RESISTOR, Composition, 560 ohm ±10%, 1/2W	905000561	AB	EB	1
Q1	TRANSISTOR, Type 2N404	910300007	RCA	2N404	2
Q2	Same as Q1				
Y1	CRYSTAL, 25,000 Hz, .01%, 1 MW Sens.	912200020	Sierra	SS-15347-1	1
	A3 MIXER-MODULATOR MODULE				
C1	CAPACITOR, Tantalum 10 µF ±20% 15 WVDC	902740106	T. I.	SCM-106-BP015D4	4
C2	Same as C1				
C3	Same as C1				
C4	CAPACITOR, Dura Mica, 5 pF, ±10%, 500V	901900050	El Menco	DM-15C-050K	1
C5	CAPACITOR, Var. Glass-Plastic .8-8.5 pF	903000885	Erie	563-013	1
C6	CAPACITOR, Disc Ceramic, .01 µF 150 WVDC	901440103	Centralab	DDM-103	2
C7	CAPACITOR, Dura Mica, 3900 pF, 500VDCW, ±2%	901910102	El Menco	DM19-392G	1
C8	CAPACITOR, Dura Mica 270 pF, 500V	901900271	El Menco	DM15-271J	1
C9	Same as C6				
C10	Same as C1				
CR1	DIODE, (matched set CR1-CR4)	910500116	Hughes	HP5082-2815	1
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
L1	COIL, 55 µH Q = 50	909400025	Sierra	B934120-2	1
Q1	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	2
Q2	Same as Q1				
R1	RESISTOR, Composition, 3,900 ohm ±10%, 1/2W	905200392	AB	EB	1
R2	RESISTOR, Composition, 33,000 ohm ±10%, 1/2W	905200333	AB	EB	1
R3	RESISTOR, Composition, 56,000 ohm ±10%, 1/2W	905200563	AB	EB	1
R4	RESISTOR, Composition, 6,800 ohm ±10%, 1/2W	905200682	AB	EB	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A3 MIXER-MODULATOR MODULE (Continued)				
R5	RESISTOR, Composition, Cermet Trimmer 200 ohm ±10%	907900218	CTS	185PC201A	1
R6	RESISTOR, Composition, 390 ohm ±5%, 1/2W	905000391	AB	EB	4
R7	Same as R6				
R8	Same as R6				
R9	Same as R6				
R10	RESISTOR, Composition, 22,000 ohm ±5%, 1/2W	905000223	AB	EB	1
R11	RESISTOR, Composition, 27,000 ohm ±5%, 1/2W	905000273	AB	EB	1
R12	RESISTOR, Composition, 3.3K ohm ±5%, 1/2W	905000332	AB	EB	1
R13	Not Used				
R14	Not Used				
R15	Not Used				
R16	Not Used				
R17	RESISTOR, Composition, 330 ohm ±5%, 1/2W	905000331	AB	EB	1
T1	TRANSFORMER 1 (C.T.): 1 (C.T.)	909900018	Pulse Eng.	PE5182	2
T2	Same as T1				
	A4 VARIABLE OSCILLATOR MODULE				
C1	CAPACITOR, Disc. .01 µF ±20%, 600 WVDC	901420103	Centralab	DD6103	3
C2	CAPACITOR, Silver Mica, 150 pF ±5%, 500 WVDC	902010151	El Menco	CM-15-E-151J	1
C3	CAPACITOR, Silver Mica, 1000 pF ±5%, 500 WVDC	902010102	El Menco	CM-20-E-102J	1
C4	CAPACITOR, Silver Mica, 4,700 pF ±5%, 300 WVDC	902010472	El Menco	CM-20-E-472J	1
C5	CAPACITOR, Variable .7-12 pF NPO	903000120	JFD	VC 11G	1
C6	CAPACITOR, Silver Mica 22 pF ±5%, 500 WVDC	902000220	El Menco	CM-15-C-220J	1
C7	Same as C1				
C8	CAPACITOR, Rod T.C. 22 pF ±2%	901410220	Centralab	TCA-22	1
C9	CAPACITOR, Variable Air 7-75 pF	902800750	Hammarlund	SS-15948-3F	1
C10	Same as C1				
C11	CAPACITOR, Feed-Through .0015µF ±20%, 500VDCW	902610152	Erie	362	1
C12	CAPACITOR, Disc. .1 µF ±20%, 100 VDCW	901410104	Sprague	33C41B6	2
C13	Same as C12				
C14	CAPACITOR, 22 pF ±2%, NPO	901420220	Centralab	TCZ-22	1
L1	COIL, 47 µH ±5%, 50 mA	909000107	Miller	70F475A1	1
L2	COIL, 67 - 135 µH	174911000	Sierra	SS-17491-1	1
L3	COIL, 330 µH ±5%, 50 mA	909000106	Miller	70F334A1	1
Q1	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	2
Q2	Same as Q1				
	TRANSISTOR STANDOFF (2)	915100049	Regan	1932XM	2
R1	RESISTOR, Composition, 5,600 ohm ±10%, 1/2W	905200562	AB	EB	2
R2	RESISTOR, Composition, 1,500 ohm ±10%, 1/2W	905200152	AB	EB	3
R3	Same as R1				
R4	RESISTOR, Composition, 2,700 ohm ±10%, 1/2W	905200272	AB	EB	1
R5	RESISTOR, Composition, 12,000 ohm ±10%, 1/2W	905200123	AB	EB	2
R6	Same as R5				
R7	Same as R2				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A4 VARIABLE OSCILLATOR MODULE (Continued)				
R8	Not Used				
R9	Same as R2				
	A5A FIRST IF, AMPLIFIER MODULE				
C1	CAPACITOR, Disc., .01 µF ±20%, 600 WVDC	901420103	Centralab	DD-6103	7
C2	Same as C1				
C3	CAPACITOR, Mica, 4700 pF ±5%, 500 WVDC	901900472	El Menco	DM-19F-472J	4
C4	Not Used				
C5	CAPACITOR, Silver Mica, 56 pF ±5%, 500 WVDC	902000560	El Menco	CM-15E-560J	2
C6	Same as C3				
C7	Same as C1				
C8	Same as C1				
C9	Same as C3				
C10	Same as C1				
C11	Same as C5				
C12	Same as C3				
C13	Same as C1				
C14	Same as C1				
L1	COIL, 3.2 µH	148301000	Sierra	SS-14830-1	4
L2	Same as L1				
L3	Same as L1				
L4	Same as L1				
Q1	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	3
Q2	Same as Q1				
Q3	Same as Q1				
R1	RESISTOR, Composition, 4,700 ohm ±5%, 1/2W	905000472	AB	EB	4
R2	RESISTOR, Composition, 22,000 ohm ±5%, 1/2W	905000223	AB	EB	3
R3	Same as R1				
R4	RESISTOR, Composition, 270 ohm ±5%, 1/2 W	905000271	AB	EB	4
R5	Same as R4				
R6	Same as R1				
R7	Same as R2				
R8	Same as R1				
R9	Same as R4				
R10	Same as R4				
R11	RESISTOR, Composition, 5,600 ohm ±5%, 1/2W	905000562	AB	EB	1
R12	Same as R2				
R13	RESISTOR, Composition, 2,200 ohm ±5%, 1/2W	905000222	AB	EB	1
R14	RESISTOR, Composition, 1,000 ohm ±5%, 1/2W	905000102	AB	EB	1
	A5B 2ND LO AND AUDIO IF AMPLIFIER MODULE				
C15	CAPACITOR, Silver Mica, 47 pF ±5%, 500 WVDC	902010470	El Menco	CM-15E-470J	2
C16	CAPACITOR, Silver Mica, 1000 pF ±5%, 500 WVDC	902010102	El Menco	CM-20E-102J	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A5B 2ND LO AND AUDIO IF AMPLIFIER MODULE (Continued)				
C17	CAPACITOR, Silver Mica, 100 pF ±5%, 500 WVDC	902010101	El Menco	CM-15E-101J	1
C18	CAPACITOR, Disc Ceram., .01 µF ±20%, 600 WVDC	901420103	Centralab	DD-6103	6
C19	Same as C15				
C20	Same as C18				
C21	Same as C18				
C22	Same as C18				
C23	Same as C18				
C24	Not Used				
C25	Not Used				
C26	Same as C18				
C27	CAPACITOR, Disc Ceram., 0.1 µF ±20%, 100 WVDC	901410104	Sprague	33C41B6	1
L5	COIL, Choke, 3.3 µH ±10%	909000116	J.W. Miller	70F333A1	1
L6	COIL, Choke, 330 µH ±5%	909000106	J.W. Miller	70F334A1	2
L7	Same as L6				
Y1	CRYSTAL, 1640 kHz ±.005%	912200019	Sierra	SS-17170-1	1
FL1	FILTER BANDPASS, Ceramic, 330 kHz, 2.5 kHz PB	910100010	Clevite	A01718400	1
Q4	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	3
Q5	Same as Q4				
Q6	Not Used				
Q7	Same as Q4				
R15	RESISTOR, Composition, 4700 ohms ±5%, 1/2W	905000472	AB	EB	3
R16	RESISTOR, Composition, 47,000 ohms ±5%, 1/2W	905000473	AB	EB	1
R17	Same as R15				
R18	RESISTOR, Composition, 680 ohms ±5%, 1/2W	905000681	AB	EB	1
R19	RESISTOR, Composition, 2200 ohms ±5%, 1/2W	905000332	AB	EB	1
R20	RESISTOR, Composition, 12,000 ohms ±5%, 1/2W	905000123	AB	EB	1
R21	RESISTOR, Composition, 10,000 ohms ±5%, 1/2W	905000103	AB	EB	1
R22	RESISTOR, Composition, 27 ohms ±5%, 1/2W	905000270	AB	EB	1
R23	RESISTOR, Composition, 3900 ohms ±5%, 1/2W	905000392	AB	EB	2
R24	Not Used				
R25	Not Used				
R26	Not Used				
R27	Not Used				
R28	Not Used				
R29	RESISTOR, Composition, 3,300 ohms ±5%, 1/2W	905000332	AB	EB	1
R30	Same as R23				
R31	Same as R15				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A6 AUDIO DETECTOR AND AMPLIFIER MODULE				
C1	CAPACITOR, Disc. 0.1 mf ±20% 100 WVDC	901410104	Sprague	33C41B6	3
C2	Same as C1				
C3	CAPACITOR, Tantalum 22 mf ±20% 15 WVDC	902740226	T. I.	SCM-226-BP015D4	2
C4	CAPACITOR, 1000 pF ±5% 500 WVDC	902010102	Elmenco	CM-20-E-102J	2
C5	CAPACITOR, 1500 pF ±5% 500 WVDC	902010152	Elmenco	CM-20-E-152J	1
C6	Same as C1				
C7	CAPACITOR, Tantalum 10 mf ±20% 15 WVDC	902740106	T. I.	SCM-106-BP015D4	1
C8	Same as C3				
C9	CAPACITOR, Electrolytic, 157 mf 15 WVDC	902201577	Whale Elect.	22-375-157-15-6PA	1
C10	Same as C4				
CR1	DIODE, Germanium Type 1N191	910600191	G. E.	1N191	1
R1	RESISTOR, Composition 22,000 ohm ±5% 1/2 Watt	905000223	AB	EB	2
R2	RESISTOR, Composition 8200 ohm ±5% 1/2Watt	905000822	AB	EB	1
R3	RESISTOR, Composition 150,000 ohm ±5% 1/2 Watt	905000154	AB	EB	1
R4	RESISTOR, Composition 2200 ohm ±5% 1/2 Watt	905000222	AB	EB	1
R5	RESISTOR, Composition 10,000 ohm ±5% 1/2 Watt	905000103	AB	EB	1
R6	RESISTOR, Composition 4700 ohm ±5% 1/2 Watt	905000472	AB	EB	1
R7	RESISTOR, Composition 47000 ohm ±5% 1/2 Watt	905000473	AB	EB	1
R8	RESISTOR, Composition 6800 ohm ±5% 1/2 Watt	905000682	AB	EB	1
R9	RESISTOR, Composition 1000 ohm ±5% 1/2 Watt	905000102	AB	EB	1
R10	Same as R1				
R11	RESISTOR, Composition 100 ohm ±5% 1/2 Watt	905000101	AB	EB	1
R12	RESISTOR, Composition 1800 ohm ±5% 1/2 Watt	905000182	AB	EB	1
R13	RESISTOR, Composition 820 ohm ±5% 1/2 Watt	905000821	AB	EB	1
R14	RESISTOR, Potentiometer 5000 ohm	907900126	Stackpole	L	1
Q1	TRANSISTOR, Type 2N1728	901030008	Philco	2N1728	1
Q2	TRANSISTOR, Type 2N404	901030007	RCA	2N404	2
Q3	Same as Q2				
J5	Not Used				
J6	JACK, Phone, with Insulated SPST Contacts	914400013	Switchcraft	Type 13	1
J7	JACK, Phone, 2 Cond.	914400003	Switchcraft	Type 11	1
	A7 2ND IF. AMPLIFIER MODULE				
C1	CAPACITOR, Disc. .01 mf ±20% 600 WVDC	901420103	Centralab	DD-6103	6
C2	Same as C1				
C3	Same as C1				
C4	CAPACITOR, Silver Mica 4,700 pF ±5% 300 WVDC or equiv.	902010472	Elmenco	CM-20-E-472J	2
C5	Not Used				
C6	Not Used				
C7	Not Used				
C8	Same as C1				
C9	Same as C4				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A7 2ND IF. AMPLIFIER MODULE (Continued)				
C10	Same as C1				
C11	Same as C1				
C12	CAPACITOR, Disc. 0.1 mf ±20% 100 WVDC	901410104	Sprague	33C41B6	3
C13	Same as C12				
C14	Same as C12				
FL1	FILTER, Crystal, B.P. 330 kHz, BW-500 Hz or equiv.	910100009	Sierra	SS-18003-1	1
L1	COIL, Variable 50 µH	148401000	Sierra	SS-14840-1	2
L2	Not Used				
L3	Same as L1				
L4	COIL, Choke 330 µH ±5%	909000106	J.W. Miller	70F334A1	3
L5	Same as L4				
L6	Same as L4				
Q1	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	2
Q2	Not Used				
Q3	Same as Q1				
R1	RESISTOR, Composition, 4,700 ohm ±5% 1/2 Watt	905000472	AB	EB	1
R2	RESISTOR, Composition, 68,000 ohm ±10% 1/2 Watt	905200683	AB	EB	1
R3	RESISTOR, Composition, 10,000 ohm ±10% 1/2 Watt	905200103	AB	EB	1
R4	RESISTOR, Composition, 1,000 ohm ±10% 1/2 Watt	905200102	AB	EB	1
R5	RESISTOR, Composition, 560 ohm ±10% 1/2 Watt	905200561	AB	EB	1
R6	Not Used				
R7	Not Used				
R8	Not Used				
R9	Not Used				
R10	RESISTOR, Composition, 22,000Ω ±10% 1/2 Watt	905200223	AB	EB	2
R11	Same as R10				
R12	RESISTOR, Composition, 56 ohm ±10% 1/2 Watt	905200560	AB	EB	1
R13	POTENTIOMETER, 5000 ohm ±30% 1/2 Watt Slotted Shaft	907900191	Sierra	A02060500	1
	A8 METER AMPLIFIER MODULE				
C1	CAPACITOR, Disc. 0.1 mf ±20% 100 WVDC	901410104	Sprague	33C41B6	6
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	Same as C1				
C6	Same as C1				
CR1	DIODE, Germanium Type 1N191	910600191	G. E.	1N191	2
CR2	Same as CR1				
M1	METER, 200 Microamperes	911800063	Sierra	A01946900	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	A8 METER AMPLIFIER MODULE (Continued)				
R1	RESISTOR, Composition 68,000 ohm ±5% 1/2 Watt	905000683	AB	EB	1
R2	RESISTOR, Composition 5,600 ohm ±5% 1/2 Watt	905000562	AB	EB	1
R3	RESISTOR, Composition 6,800 ohm ±5% 1/2 Watt	905000682	AB	EB	1
R4	RESISTOR, Composition 330 ohm ±5% 1/2 Watt	905000331	AB	EB	1
R5	RESISTOR, Composition 22,000 ohm ±5% 1/2 Watt	905000223	AB	EB	1
R6	RESISTOR, Composition 6,800 ohm ±5% 1/2 Watt	905000682	AB	EB	1
R7	RESISTOR, Composition 3,900 ohm ±5% 1/2 Watt	905000392	AB	EB	1
R8	RESISTOR, Composition 1,800 ohm ±5% 1/2 Watt	905000182	AB	EB	1
R9	RESISTOR, Composition 560 ohm ±5% 1/2 Watt	905000561	AB	EB	1
R10	RESISTOR, Composition 150 ohm ±5% 1/2 Watt	905000151	AB	EB	1
R11	RESISTOR, Deposited Carbon 46,240 ohm ±1% 1/2 Watt	907400141	Electra	DC 1/2A	1
Q1	TRANSISTOR, Type 2N1728	910300008	Philco	2N1728	2
Q2	Same as Q1				
	BATTERY PACK				
BTY1	BATTERY, Zinc Carbon, 1.5 Volts, Size D	918500006	Mallory	N13R	6
BTY2	Same as BTY1				
BTY3	Same as BTY1				
BTY4	Same as BTY1				
BTY5	Same as BTY1				
BTY6	Same as BTY1				
	A9 MODULE NOT USED				
	A10 METER DAMPING MODULE				
C1	CAPACITOR, Tantalum, 180 mf ±10%, 6 WVDC	902700187	Sprague	150D187x9006R2	1
R1	RESISTOR, Composition, 1,800 ohm ±5% 1/2W	905000182	AB	EB	1
	KNOB, INSTRUMENT, Round w/o Skirt, 1" Dia.	916000037			1
	KNOB, INSTRUMENT, Round w/o Skirt, 1-1/2" Dia.	916000043			1
	KNOB, INSTRUMENT, Concentric, 1-11/16" Dia.	916000058			1
	KNOB, INSTRUMENT, Round, w/o Skirt, 5/8" Dia.	916000042			1
	KNOB, INSTRUMENT, Single Bar w/o Skirt, 5/8" Dia.	916000047			3

Warranty

SIERRA ELECTRONIC OPERATION, PHILCO-FORD CORPORATION warrants instruments manufactured by it and bearing Sierra commercial model numbers, to be free from defective material and factory workmanship and agrees to repair such instruments, which under normal use and service, disclose the defects to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any such instrument which in our sole opinion upon our examination proves to be so defective, when returned to our factory at 3885 Bohannon Drive, Menlo Park, California 94025, transportation prepaid by the purchaser, within one year from the date of original purchase from us.

This warranty does not apply to any products which have been repaired, worked upon or altered by persons not authorized by us so as, in our sole judgement, to injure the stability or reliability of such instrument, or which have been subject to misuse, negligence or accident, or the serial number of which has been altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by us. Nor does SIERRA assume any liability for consequential damages, and in any event our liability shall in no case exceed the original purchase price of the instrument. Accessories, including but not limited to all vacuum tubes, fuses and batteries, not of our manufacture used with this product are not covered by this warranty.

SIERRA reserves the right to make changes in the design or construction of any of its instruments at any time without incurring any obligation to make any changes whatever on units previously purchased.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to represent nor assume for us any liability in connection with the sale of our products other than set forth herein. In no event will seller be liable for any incidental or consequential damages.